

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L6	3	(singulat\$3 and (dice or substrate or die) and (diaphragm) and (fluid with pressure) and (groove or trench or recess or aperture or hole or opening)).clm.	US-PGPUB; USPAT	OR	ON	2005/09/28 10:37
L7	11	(singulat\$3 and (dice or substrate or die) and (diaphragm) and (fluid with pressure) and (groove or trench or recess or aperture or hole or opening))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2005/09/28 10:32
L8	4030	438/106,110,113,460,463,464.ccls.	US-PGPUB; USPAT	OR	ON	2005/09/28 10:39
L9	3364	8 and @ad<"20031027"	US-PGPUB; USPAT	OR	ON	2005/09/28 10:39

DOCUMENT-IDENTIFIER: US 20050145166 A1

TITLE: Jet singulation

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Abstract Paragraph - ABTX (1):

Techniques for singulating a substrate into a plurality of component parts is disclosed. The singulation techniques include generating a jet stream in order to cut through large components so as to produce smaller components. The techniques are particularly suitable for singulating surface mount devices such as chip scale packages, ball grid arrays (BGA), flip chips, lead less packages (QFN) and the like. The techniques are also suitable for singulating photonic devices.

Title - TTL (1):

Jet singulation

Cross Reference to Related Applications Paragraph

- CRTX (1):

[0001] This application claims the priority of U.S. Provisional Patent Application No.: 60/410,744 entitled "JET SINGULATION", filed on Sep. 13, 2002 and which is incorporated herein by reference.

Summary of Invention Paragraph - BSTX (2):

[0002] The invention generally relates to integrated circuit processing equipment. More particularly, the invention relates to an improved apparatus and method of singulating a substrate into a plurality of component parts.

Summary of Invention Paragraph - BSTX (4):

[0003] A singulation procedure is typically performed to separate integrated circuit packages such as IC chips from a substrate such as a circuit board. During singulation, the substrate is typically held in place while one or more saw blades cut straight lines through the substrate to form the individual integrated circuit packages. Although dicing with saw blades has worked well, continuing advancements in the industry have tested the limitations of saw singulation.

Summary of Invention Paragraph - BSTX (5):

[0004] Cutting small devices is particularly problematic for saw

singulation. When device dimensions are small as for example less than 3 mm.times.3 mm, vacuum fixtures are unable to retain the small devices during sawing, with consistency. As the saw blade passes through a device, it is both rotating and translating relative to the device under process. The resulting force vectors have both vertical and shear components. As the shear component overwhelms the holding force of the vacuum fixture, the **singulation** yield drops due to non-conforming geometries, damage, or lost parts. As feed rates increase, the magnitude of the shear component increases commensurately and magnifies the device retention problem. Therefore, feed rates are minimized to protect yields. The result, however, is lower throughput.

Summary of Invention Paragraph - BSTX (6):

[0005] High consumable cost is also problematic for saw **singulation**. Saw **singulation** may require specially formulated blades that must constantly expose new diamonds to the cut interface. As the diamonds remove material, they are "dulled" by the materials used in the substrate and must be sloughed-off as the blade wears at a higher-than-normal rate. The balance between blade wear and cut quality is a delicate trade-off requiring costly technology to extend blade life while minimizing burrs and chips.

Summary of Invention Paragraph - BSTX (7):

[0006] Curvilinear cutting paths are also problematic for saw **singulation**. Many new devices as for example photonic devices are produced with precise curved boundaries rather than straight edges. Curved boundaries require curvilinear cut paths, which saw blades do not readily accommodate. By definition, the cut path of a rotating blade must be the straight line defined by the intersection of the blade plane and the device plane. Saw **singulation** simply does not lend itself to curvilinear cutting paths as needed by these new devices.

Summary of Invention Paragraph - BSTX (8):

[0007] Based on the foregoing, there is desired an improved apparatus and method of **singulating a substrate** into a plurality of component parts.

Summary of Invention Paragraph - BSTX (10):

[0008] The invention relates, in one embodiment, to a **singulation** engine configured to produce a cutting beam capable of cutting through a substrate in order to form small discrete parts. The **singulation** engine includes an abrasive delivery system and a nozzle operatively coupled to the abrasive delivery system. The abrasive delivery system is configured to supply an abrasive slurry to the nozzle and the nozzle is configured to produce a cutting beam with the abrasive slurry. The abrasive slurry is formed by an abrasive

and a fluid. The abrasive delivery system includes a pump a slurry vessel and a slurry source. The pump is configured to force the abrasive slurry out of the slurry vessel and deliver the abrasive slurry to the nozzle. The slurry vessel is configured to contain the abrasive slurry. The slurry source is configured to supply the components of the abrasive slurry to the slurry vessel.

Summary of Invention Paragraph - BSTX (11):

[0009] The invention relates, in another embodiment, to a singulation engine for singulating a substrate into a plurality of smaller component parts. The singulation engine includes a gang manifold assembly including a manifold configured to distribute a slurry to a plurality of nozzles. Each of the nozzles being configured to discharge an individual jet stream in the form of a beam for cutting through the substrate at the same time. The singulation engine further includes a chuck assembly configured to hold and support the substrate and the smaller component parts formed therefrom before, during and after the jet stream cuts through the substrate.

Summary of Invention Paragraph - BSTX (12):

[0010] The invention relates, in another embodiment, to a vacuum chuck assembly configured to hold an unsingulated substrate and the singulated substrate parts cut therefrom before, during and after jet stream singulation. The vacuum chuck assembly includes a first chuck configured to hold the substrate during x axis cutting, the first chuck including a plurality of vacuum passageways and a plurality of cutting slots. The vacuum passageways are configured to provide suction to the substrate in order to hold the substrate before, during and after jet stream singulation. The cutting slots provide a space through which a jet stream passes when cutting in a first direction. The vacuum chuck assembly also includes a second chuck configured to hold the substrate during y axis cutting. The second chuck includes a plurality of vacuum passageways and a plurality of cutting slots. The vacuum passageways are configured to provide suction to the substrate in order to hold the substrate before, during and after jet stream singulation. The cutting slots provide a space through which a jet stream passes when cutting in a second direction that is orthogonal to the first direction.

Summary of Invention Paragraph - BSTX (13):

[0011] The invention relates, in another embodiment, to a method of singulating a substrate having a plurality of integrated circuits formed thereon. The method includes producing one or more jet streams in the form of a beam. The configuration of the jet streams being sufficient to cut the substrate. The method also includes directing the jet streams over the surface

of the substrate. The method further includes selectively operating the jet streams so as to cut the substrate into the plurality of integrated circuits.

Summary of Invention Paragraph - BSTX (14):

[0012] The invention relates, in another embodiment, to a method of separating a substrate into a plurality of integrated circuit chips. The substrate and plurality of integrated circuit chips have a first side that is smoother than a second side. Each of the plurality of integrated circuit chips includes an array of contacts at said second side. The method includes providing a vacuum platform having a plurality of vacuum openings. Each of the vacuum openings correspond to individual ones of said plurality of integrated circuit chips. Each of the vacuum openings are surrounded by an upper surface of the vacuum platform. The method further includes disposing the first side of the substrate on the upper surface of the vacuum platform. The method additionally includes holding the first side of the substrate against the upper surface of the vacuum platform with a vacuum. Moreover, the method includes cutting the substrate into the plurality of integrated circuit chips while the substrate is held against the upper surface of the vacuum platform. The cutting is performed by a jet stream formed into a beam.

Brief Description of Drawings Paragraph - DRTX

(8):

[0020] FIG. 3C is a top view of a group of singulated lead less integrated circuit packages.

Brief Description of Drawings Paragraph - DRTX

(9):

[0021] FIG. 3D is a side view of a singulated integrated circuit package.

Brief Description of Drawings Paragraph - DRTX

(10):

[0022] FIG. 3E is a perspective view of a singulated integrated circuit package.

Brief Description of Drawings Paragraph - DRTX

(12):

[0024] FIG. 4B is a top view of a group of singulated BGA integrated circuit packages.

Brief Description of Drawings Paragraph - DRTX

(13):

[0025] FIG. 4C is a side view of a singulated BGA integrated circuit

package.

Brief Description of Drawings Paragraph - DRTX

(14):

[0026] FIG. 4D is a perspective view of a singulated BGA integrated circuit package.

Brief Description of Drawings Paragraph - DRTX

(15):

[0027] FIG. 5 is an illustration showing a photonic devices after singulation.

Brief Description of Drawings Paragraph - DRTX

(16):

[0028] FIG. 6 is a simplified diagram of a singulation engine, in accordance with one embodiment of the present invention.

Brief Description of Drawings Paragraph - DRTX

(38):

[0050] FIG. 25 is a simplified diagram of a singulation engine, in accordance with one embodiment of the present invention.

Detail Description Paragraph - DETX (2):

[0052] The present invention generally relates to an improved apparatus and method for singulating a substrate into a plurality of component parts. More particularly, the invention relates to a singulation system capable of singulating integrated circuit devices (e.g., dies, unpackaged chips, packaged chips, and the like). The singulation system is configured to generate a jet stream that contains an abrasive and fluid that cuts through large components so as to produce smaller components. The system described herein is particularly suitable for singulating surface mount devices such as chip scale packages, ball grid arrays (BGA), flip chips, lead less packages (QFN) and the like. The system is also suitable for singulating photonic devices.

Detail Description Paragraph - DETX (3):

[0053] Water jet machining has been available for decades; however, its potential has never been realized in semiconductor manufacturing. The fine geometries required by semiconductor manufacturers were beyond the reach of traditional water jets and their nozzle technologies. Though small aperture nozzles delivered sufficiently fine beams of water, the nozzle aperture would increase with use causing unacceptable deviations from target geometries. In addition, traditional water jets rely on the impact forces of high-energy water